PAPERS ON CLIMATOLOGY IN RELATION TO AGRICULTURE, TRANSPORTATION, WATER RESOURCES, ETC.

A METHOD FOR REDUCING A SHORT-RECORD TEMPERATURE MEAN TO THE 33-YEAR NORMAL.

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It is very desirable to reduce all the cooperative temperature observations, as well as those of the regular Weather Bureau stations, to the same homogeneous system. Bulletin S contains the data for about 100 regular Weather Bureau stations having a long record, which have been already reduced to the 33-year normal, now in use by the Weather Bureau. From this bulletin can be obtained a system of homogeneous departures of temperature for each month by subtracting the 33-year normal from the monthly mean temperature. When these departures are assembled on charts of the United States, lines of equal departure can be drawn which will display the monthly variations of the temperature in respect to the adopted normal basis. Such charts have been prepared and are now being printed by the chalk-plate process at several stations, and they will be collected in a volume. These charts are complete from January, 1873, to July, 1909, 475 in number, including the annual charts for each year. This series is being continued in the MONTHLY WEATHER REVIEW, and will in the future show the temperature variations in the United States.

It is obvious that by interpolation from these charts the departures of temperature can be obtained for each month of any year of the series at all other stations in the United States. For the cooperative stations it is, therefore, necessary only to fix the point on the chart and read off as carefully as possible the apparent departure of temperature for the month. As an example of the method of computation the accompanying table for Dayton, Ohio, exhibits the details of the computation in full.

Take the series of years available at the station, as 1896 to 1908, inclusive, for Dayton. Write down the monthly mean temperatures for each year and take the mean. Subtract this mean from each temperature under T and the departures ΔT will be found in the third column. Scale off from the map the apparent departures and enter them in the fourth column under Map. Subtract in succession the values under Map from the values under ΔT and write down the algebraic difference in the fifth column. In this column of differences sum up the positive and negative values, take the algebraic sum, and divide by the number of years, 13 in this case. Thus we have for January +0.8 and −12.4, the sum being −11.6. Divide this by 13 and the mean is −0.9, which is the correction to be applied to the mean temperature of the 13 years under consideration to produce that temperature which corresponds to the 33-year normal; that is, 30.3 minus 0.9 equals 29.4. With this new normal value, 29.4, repeat the subtraction under column T and write the differences in the last column under ΔT_0. For a check add up the numbers under Map algebraically, the final sum being +11.1; and under the last column ΔT_0 add the numbers up similarly, the result being +11.2. This checks the work and shows that the adjusted normal temperature, 29.4, gives departures ΔT_0, which are in close agreement with those scaled from the maps. Similarly the correction for the February mean is +3.2, changing the temperature from 28.3 to 31.5; and so on for the other months of the year. The annual mean can be found by taking the mean of the 12 adjusted values for the month. While there is some uncertainty, of course, in scaling from the charts it is evident that if the record extends over several years these accidental errors will tend to eliminate themselves, so that the final average correction will be very near the truth.

If the section director in each State will in this way adjust the temperature records for the important cooperative stations we shall have a temperature system, whose departures will be considerably smoother than those now in use, and which will conform very closely to the long-period normal of 33 years.

Reduction of a short-record temperature mean to the 33-year normal.

DAYTON, OHIO.

Year.	January.					February.				
	T.	ΔT.	Map.	Diff.	ΔT_0.	T.	ΔT.	Map.	Diff.	ΔT_0.
	°	°	°	°	°	°	°	°	°	°
1896...	32.0	+ 1.7	+ 2.1	− 0.4	+ 2.6	33.8	+ 5.5	+ 0.6	+ 4.9	+ 2.3
1897...	27.7	− 2.6	− 2.6	0.0	− 1.7	35.2	+ 6.9	+ 2.4	+ 4.5	+ 3.7
1898...	34.0	+ 3.7	+ 4.9	− 1.2	+ 4.6	33.0	+ 4.7	+ 0.5	+ 4.2	+ 1.5
1899...	31.2	+ 0.9	+ 0.3	+ 0.6	+ 1.8	23.2	− 5.1	− 8.2	+ 3.1	− 8.3
1900...	33.8	+ 3.5	+ 3.3	+ 0.2	+ 4.4	28.5	+ 0.2	− 3.7	+ 3.9	− 3.0
1901...	30.2	− 0.1	+ 1.0	− 1.1	+ 0.8	24.4	− 3.9	− 8.0	+ 4.1	− 7.1
1902...	28.9	− 1.4	− 0.5	− 0.9	− 0.5	22.2	− 6.1	− 8.0	+ 1.9	− 9.3
1903...	28.2	− 2.1	− 0.8	− 1.3	− 1.2	32.0	+ 3.7	+ 0.3	+ 3.4	+ 0.5
1904...	21.3	− 9.0	− 6.0	− 3.0	− 8.1	25.4	− 2.9	− 5.6	+ 2.7	− 6.1
1905...	24.4	− 5.9	− 5.2	− 0.7	− 5.0	22.1	− 6.2	− 8.3	+ 2.1	− 9.4
1906...	36.0	+ 5.7	+ 7.5	− 1.8	+ 6.6	28.4	+ 0.1	0.0	+ 0.1	− 3.1
1907...	34.7	+ 4.4	+ 5.0	− 0.6	+ 5.3	29.0	+ 0.7	− 2.8	+ 3.5	− 2.5
1908...	31.0	+ 0.7	+ 2.1	− 1.4	+ 1.6	30.2	+ 1.9	− 1.6	+ 3.5	− 1.3
Means	30.3	.....	+26.2	+ 0.8	+27.7	28.3	.....	+ 3.8	+41.9	+ 8.0
	.....	.....	−15.1	−12.4	−16.5	.....	.....	−46.2	0.0	−50.1
Red. m	29.4	.....	+11.1	− 0.9	+11.2	31.5	.....	−42.4	+ 3.2	−42.1

Year.	March.					April.				
	T.	ΔT.	Map.	Diff.	ΔT_0.	T.	ΔT.	Map.	Diff.	ΔT_0.
1896...	35.6	− 6.6	− 5.6	− 1.0	− 5.2	60.0	+ 9.0	+ 7.2	+ 1.8	+ 8.2
1897...	44.8	+ 2.6	+ 3.8	− 1.2	+ 4.0	51.0	0.0	− 1.5	+ 1.5	− 0.8
1898...	47.1	+ 4.9	+ 6.0	− 1.1	+ 6.3	49.4	− 1.6	− 2.9	+ 1.3	− 2.4
1899...	39.5	− 2.7	− 2.2	− 0.5	− 1.3	56.9	+ 5.9	+ 2.9	+ 3.0	+ 5.1
1900...	35.6	+ 6.6	− 5.5	− 1.1	− 5.2	52.4	+ 1.4	+ 0.3	+ 1.1	+ 0.6
1901...	41.9	− 0.3	0.0	− 0.3	+ 1.1	48.0	− 3.0	− 3.0	0.0	− 3.8
1902...	43.0	+ 0.8	+ 3.0	− 2.2	+ 2.2	49.3	− 1.7	− 1.8	+ 0.1	− 2.5
1903...	47.6	+ 5.4	+ 7.5	− 2.1	+ 6.8	51.2	+ 0.2	− 0.4	+ 0.6	− 0.6
1904...	41.8	− 0.4	+ 0.5	− 0.9	+ 1.0	45.4	− 5.6	− 6.2	+ 0.6	− 6.4
1905...	45.8	+ 3.6	+ 5.0	− 1.4	+ 5.0	51.2	+ 0.2	− 0.7	+ 0.9	− 0.6
1906...	32.3	− 9.9	− 7.2	− 2.7	− 8.5	53.8	+ 2.8	+ 3.2	− 0.4	+ 2.0
1907...	40.4	+ 7.2	+ 8.0	− 0.8	+ 8.6	42.8	− 8.2	− 8.2	0.0	− 9.0
1908...	44.8	+ 2.6	+ 5.5	− 2.9	+ 4.0	52.2	+ 1.2	+ 1.0	+ 0.2	+ 0.4
Means	42.2	.....	+39.3	0.0	+39.0	51.0	.....	+14.6	+11.1	+16.3
			−20.5	−18.2	−20.2	.....	.....	−24.7	− 0.4	−26.1
Red. m	40.8	.....	+18.8	− 1.4	−18.8	51.8	.....	−10.1	+ 0.8	− 9.8

Year.	May.					June.				
	T.	ΔT.	Map.	Diff.	ΔT_0.	T.	ΔT.	Map.	Diff.	ΔT_0.
1896...	71.2	+ 7.9	+ 6.2	+ 1.7	+ 7.9	72.0	+ 0.8	− 0.8	+ 1.6	− 0.4
1897...	58.4	− 4.9	− 5.0	+ 0.1	− 4.9	71.1	− 0.1	− 1.8	+ 1.7	− 1.3
1898...	64.0	+ 0.7	− 0.3	+ 1.0	+ 0.7	73.7	+ 2.5	+ 2.0	+ 0.5	+ 1.3
1899...	65.4	+ 2.1	+ 1.7	+ 0.4	+ 2.1	74.2	+ 3.0	+ 1.3	+ 1.7	+ 1.8
1900...	65.2	+ 1.9	+ 1.2	+ 0.7	+ 1.9	72.4	+ 1.2	− 1.0	+ 2.2	0.0
1901...	60.4	− 2.9	− 2.8	− 0.1	− 2.9	73.8	+ 2.6	+ 0.6	+ 2.0	+ 1.4
1902...	65.4	+ 2.1	+ 1.8	+ 0.3	+ 2.1	69.8	− 1.4	− 2.8	+ 1.4	− 2.6
1903...	65.2	+ 1.9	+ 2.8	− 0.9	+ 1.9	66.0	− 5.2	− 6.3	+ 1.1	− 6.4
1904...	61.6	− 1.7	− 1.0	− 0.7	− 1.7	70.2	− 1.0	− 2.0	+ 1.0	− 2.2
1905...	62.3	− 1.0	− 0.2	− 0.8	− 1.0	71.8	+ 0.6	0.0	+ 0.6	− 0.6
1906...	63.2	− 0.1	+ 0.4	− 0.5	− 0.1	71.3	+ 0.1	− 1.0	+ 1.1	− 1.1
1907...	56.2	− 7.1	− 6.0	− 1.1	− 7.1	67.9	− 3.3	− 4.0	+ 0.7	− 4.5
1908...	64.2	+ 0.9	+ 1.6	− 0.7	+ 0.9	70.8	− 0.4	− 0.8	+ 0.4	− 1.6
Means	63.3	.....	+15.7	+ 4.2	+17.5	71.2	.....	+ 3.9	+16.0	+ 4.5
	.....	.....	−15.3	− 4.8	−17.7	.....	.....	−20.5	0.0	−20.7
Red. m	63.3	.....	+ 0.4	0.0	− 0.2	72.4	.....	−16.6	+ 1.2	−16.2

Year.	July.					August.				
	T.	ΔT.	Map.	Diff.	ΔT_0.	T.	ΔT.	Map.	Diff.	ΔT_0.
1896...	76.5	+ 0.6	− 1.6	+ 2.2	+ 0.3	74.4	0.0	− 0.2	+ 0.2	+ 0.2
1897...	78.5	+ 2.6	+ 0.6	+ 2.0	+ 2.3	71.9	− 2.5	− 2.3	− 0.2	− 2.3
1898...	74.2	− 1.7	+ 0.7	− 2.4	− 2.0	75.2	+ 0.8	+ 1.2	− 0.4	+ 1.0
1899...	76.0	+ 0.1	− 0.8	+ 0.9	− 0.2	76.6	+ 2.2	+ 2.2	0.0	+ 2.4
1900...	76.4	+ 0.5	− 0.7	+ 1.2	+ 0.2	79.2	+ 4.8	+ 4.5	+ 0.3	+ 5.0
1901...	80.7	+ 4.8	+ 4.2	+ 0.6	+ 4.5	75.8	+ 1.4	+ 1.0	+ 0.4	+ 1.6
1902...	75.8	− 0.1	− 0.2	+ 0.1	− 0.4	71.9	− 2.5	− 2.0	− 0.5	− 2.3
1903...	75.2	− 0.7	− 0.4	− 0.3	− 1.0	74.3	− 0.1	− 1.8	+ 1.7	+ 0.1
1904...	73.6	− 2.3	− 2.7	+ 0.4	− 2.6	71.6	− 2.8	− 2.0	− 0.8	− 2.6
1905...	74.8	− 1.1	− 1.7	+ 0.6	− 1.4	74.0	− 0.4	+ 0.2	− 0.6	− 0.2
1906...	74.0	− 1.9	− 1.8	− 0.3	− 2.2	76.6	+ 2.2	+ 3.2	− 1.0	+ 2.4
1907...	75.0	− 0.9	− 1.0	+ 0.1	− 1.2	71.6	− 2.8	− 1.6	− 1.2	− 2.6
1908...	75.8	− 0.1	+ 0.6	− 0.7	− 0.4	73.8	− 0.6	+ 0.3	− 0.9	− 0.4
Means	75.9	.....	+ 6.1	+ 8.1	+ 7.3	74.4	.....	+12.6	+ 2.6	+12.7
	.....	.....	−10.7	− 3.7	−11.4	.....	.....	− 9.9	− 5.6	−10.2
Red. m	76.2	.....	− 4.6	+ 0.3	− 4.1	74.2	.....	+ 2.7	− 0.2	+ 2.5

Reduction of a short-record temperature mean to the 33-year normal.

DAYTON, OHIO—Continued.

Year.	September.					October.				
	T.	ΔT.	Map.	Diff.	ΔT_0.	T.	ΔT.	Map.	Diff.	ΔT_0.
	°	°	°	°	°	°	°	°	°	°
1896...	64.4	− 3.6	− 3.0	− 0.6	− 2.9	51.0	− 4.7	− 4.0	− 0.7	− 4.1
1897...	69.0	+ 1.0	+ 2.0	− 1.0	+ 1.7	60.4	+ 4.7	+ 4.8	− 0.1	+ 5.3
1898...	70.6	+ 2.6	+ 2.5	+ 0.1	+ 3.3	56.4	+ 0.7	− 0.2	+ 0.9	+ 1.3
1899...	67.2	− 0.8	− 1.9	+ 1.1	− 0.1	59.4	+ 3.7	+ 3.8	− 0.1	+ 4.3
1900...	72.8	+ 4.8	+ 4.0	+ 0.8	+ 5.5	63.0	+ 7.3	+ 7.0	+ 0.3	+ 7.9
1901...	66.7	− 1.3	− 0.4	− 0.9	− 0.6	54.8	− 0.9	0.0	− 0.9	− 0.3
1902...	65.4	− 2.6	− 2.2	− 0.4	− 1.9	56.4	+ 0.7	+ 1.2	− 0.5	+ 1.3
1903...	67.4	− 0.6	0.0	− 0.6	+ 0.1	55.6	− 0.1	− 0.2	+ 0.1	+ 0.5
1904...	66.6	− 1.4	0.0	− 1.4	− 0.7	53.6	− 2.1	− 1.6	− 0.5	− 1.5
1905...	66.8	− 1.2	+ 0.7	− 1.9	− 0.5	53.8	− 1.9	− 0.9	− 1.0	− 1.3
1906...	70.8	+ 2.8	+ 3.5	− 0.7	+ 3.5	53.8	− 1.9	+ 0.1	− 2.0	− 1.3
1907...	67.2	− 0.8	+ 0.4	− 1.2	− 0.1	50.6	− 5.1	− 3.8	− 1.3	− 4.5
1908...	69.2	+ 1.2	+ 4.0	− 2.8	+ 1.9	54.9	− 0.8	+ 1.0	− 1.8	− 0.2
Means	68.0	.....	+17.1	+ 2.0	+16.0	55.7	.....	+17.9	+ 1.3	+20.6
	.....	.....	− 7.5	−11.5	− 6.8	.....	.....	−10.7	− 8.9	−13.2
Red.m	67.3	.....	+ 9.6	− 0.7	+ 9.2	55.1	.....	+ 7.2	− 0.6	+ 7.4

Reduction of a short-record temperature mean to the 33-year normal.

DAYTON, OHIO—Continued.

Year.	November.					December.				
	T.	ΔT.	Map.	Diff.	ΔT_0.	T.	ΔT.	Map.	Diff.	ΔT_0.
	°	°	°	°	°	°	°	°	°	°
1896...	46.8	+ 4.1	+ 3.0	+ 1.1	+ 4.5	36.2	+ 4.4	+ 1.7	+ 2.7	+ 2.9
1897...	44.2	+ 1.5	+ 1.3	+ 0.2	+ 1.9	34.0	+ 2.2	+ 0.4	+ 1.8	+ 0.7
1898...	40.9	− 1.8	− 2.2	+ 0.4	− 1.4	29.6	− 2.2	− 3.6	+ 1.4	− 3.7
1899...	45.7	+ 3.0	+ 3.6	− 0.6	+ 3.4	31.2	− 0.6	− 2.5	+ 1.9	− 2.1
1900...	43.0	+ 0.3	+ 0.5	− 0.2	+ 0.7	33.0	+ 1.2	− 0.3	+ 1.5	− 0.3
1901...	38.4	− 4.3	− 3.6	− 0.7	− 3.9	27.7	− 4.1	− 5.0	+ 0.9	− 5.6
1902...	49.8	+ 7.1	+ 7.7	− 0.6	+ 7.5	30.6	− 1.2	− 2.0	+ 0.8	− 2.7
1903...	38.2	− 4.5	− 4.0	− 0.5	− 4.1	25.8	− 6.0	− 8.1	+ 2.1	− 7.5
1904...	41.8	− 0.9	0.0	− 0.9	− 0.5	29.3	− 2.5	− 3.5	+ 1.0	− 4.0
1905...	41.2	− 1.5	− 1.7	+ 0.2	− 1.1	33.6	+ 1.8	+ 0.4	+ 1.4	+ 0.3
1906...	41.9	− 0.8	0.0	− 0.8	− 0.4	33.5	+ 1.7	0.0	+ 1.7	+ 0.2
1907...	39.8	− 2.9	− 1.0	− 1.9	− 2.5	34.3	+ 2.5	+ 2.0	+ 0.5	+ 1.0
1908...	43.3	+ 0.6	+ 2.0	− 1.4	+ 1.0	35.2	+ 3.4	+ 1.7	+ 1.7	+ 1.9
Means	42.7	.....	+18.1	+ 1.9	+19.0	31.8	.....	+ 6.2	+19.4	+ 7.0
	.....	.....	−12.5	− 7.4	−13.9	.....	.....	−25.0	0.0	−26.2
Red.m	42.3	.....	+ 5.6	− 0.4	+ 5.1	33.3	.....	−18.8	+ 1.5	−19.2